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Analysis

Using REDD + to balance timber production with conservation objectives in a mangrove forest in Malaysia

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ABSTRACT

In this paper we evaluate if REDD + initiatives might be financially viable to be used to achieve a more sustainable balance between timber production and ecosystem health in a mangrove forest area in Malaysia. The focus of our study is on a 40,466 ha mangrove forest in Malaysia known as the Matang Mangrove Forest Reserve. The Matang Mangrove Forest Reserve has been used for charcoal and pole production for over 100 years and is often described as a good example of a sustainably managed multi-use mangrove forest. However, recent research shows that the health of various components of the ecosystem is in decline (notably some bird species and the blood cockle fishery). We use opportunity cost analysis to determine that the minimum compensation required to offset the production revenue currently derived from timber production in the forest is less than US$0.83 tCO2e. At these relatively low costs we demonstrate that REDD + is financially viable to be strategically used to support the conservation of some parts of the Matang Mangrove Forest Reserve which could result in better sustainable outcomes for the forest area and its stakeholders as a whole.

1. Introduction

Mangrove forests typically hold substantial stores of carbon and are therefore a logical ecosystem to consider including under climate policy initiatives such as REDD + (Reducing Emissions from Deforestation and Forest Degradation) (Laffoley and Grimsditch, 2009, Nellemann et al., 2009, Murray et al., 2011, Donato et al., 2011; Siikamäki et al., 2012, Murdiyarso et al., 2013; Lovelock and McAllister, 2013; Thomas, 2014). With a global average rate of mangrove loss of 1–2% per year and an overall estimated loss of 30–50% since the 1940s, mangrove forests are also one of our most threatened ecosystems; finding effective solutions to mangrove forest management should be an issue of global concern and priority (Valiela et al., 2001, Alongi, 2002, Millennium Ecosystem Assessment, 2005, Duke et al., 2007, FAO, 2007, Polidoro et al., 2010).

Most published research on the economics of REDD + has so far focused on terrestrial forests, rather than mangrove forests (Fisher et al., 2011, Irawan et al., 2013, Borrego and Skutsch, 2014, Skidmore et al., 2014), and used opportunity cost analysis to quantify the compensation required for different types of stakeholders in different locations to make REDD + projects theoretically financially feasible (Boucher, 2008, Wertz-Kanounnikoff, 2008, Irawan et al., 2013, Lin et al., 2014). Boucher (2008) reviewed 29 studies that applied opportunity cost analysis to determine the minimum costs per tCO_2e required to make REDD + projects in terrestrial forests in various locations theoretically financially viable, and summated a mean opportunity cost of US$2.51/$tCO_2e$; a relatively low cost in terms of global climate change mitigation options. Some more recent studies have suggested that the true costs of getting REDD + projects operational have been generally underestimated in published research, and that the costs of REDD + projects in reality are likely to be much greater (Angelsen and McNeill, 2012; Borrego and Skutsch, 2014). Making REDD + work in reality is a difficult task. The implementation of effective and equitable REDD + projects in practice is constrained by numerous factors: poor governance and insecure land tenure (Sunderlin et al., 2009, Larson, 2011); organizational fragmentation and complex sociological, ecological and economic factors (Law et al., 2012; Thomas, 2014); and technical complications in developing the monitoring, reporting and validation process (Herold and Skutsch, 2011).

In this paper we use opportunity cost analysis to evaluate if REDD + might be used to achieve more enhanced management outcomes in a production mangrove forest. Importantly, our analysis examines how REDD + might be integrated in a mangrove forest currently used for timber production. We investigate whether REDD + can be used to achieve a better balance between ecosystem health and the financial returns derived from the forest for its managing stakeholder, the Perak State Forestry Department (PSFD). Our analysis focusses on the Matang Mangrove Forest Reserve in Malaysia (MMFR). The MMFR has been managed for the extraction of timber for more than a century and provides a useful context within which to evaluate if REDD + might be used to achieve a better balance between timber production and conservation objectives.

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2. Background

2.1 Study Area

The MMFR is the largest tract of contiguous mangrove forest gazetted as a Permanent Forest Reserve in Peninsular Malaysia. It covers an area of 40,466 ha and is located in the State of Perak (Fig. 1). In Malaysia, the management of state-owned mangrove forests fall under the jurisdiction of the respective state forestry department (Jusoff and Taha, 2008). The PSFD is the custodian and manager of the MMFR. It takes precedence over other related government agencies on how the mangrove forest reserve is managed and ultimately determines the ecological outcomes (Chong, 2006, Jusoff and Taha, 2008). The systematic management of the mangrove forest reserve is based on a series of 10-year working plans, which have been continuously updated since the 1950s (Roslan and Nik Mohd. Shah, 2014).

The mangrove forest reserve is divided into four forest management zones; the Production Zone, the Restrictive Production Zone, the Protective Zone and the Unproductive Zone. The Production Zone is the largest of the all the zones and comprises 29,794 ha (73.6%) of total land coverage, the Protective Zone covers a total area of 7360 ha (18.2%), the Restrictive Production Zone comprises 2892 ha (7.2%), while the Unproductive Zone makes up an area of 420 ha (1.0%) (Azahar and Nik Mohd. Shah, 2003).

The management employs a Clear Felling and Planting silviculture system based on a 30-year rotation. Typically, the forest are clear felled when it attains 30 years of age and in between two thinnings will be conducted, at 15 and 20 years of age, respectively referred to as Thinning I and Thinning II (Gan, 1995). Natural and artificial regeneration plays an important role in restocking clear felled areas. The silviculture practices at the MMFR have been strictly focused on the continual regeneration of the more financially valuable species of the *Rhizophora* type, where the *Rhizophora apiculata* is given priority over the *Rhizophora mucronata*. This has resulted in the *Rhizophora* forest dominating an estimated 85% of the MMFR (Azahar and Nik Mohd. Shah, 2003, Alongi et al., 2004, Ong and Gong, 2013).

Adapted from (Azahar and Nik Mohd. Shah, 2003, Hamdan et al., 2013).

Although the mangrove forest reserve has been deemed as one of the best sustainably managed production mangrove forests in the world, its ecological status and ecosystem services are in need of urgent attention as multiple signs of degradation have continued to emerge (Aziz et al., 2015, Goessens et al., 2014). For example, years of continuous timber extraction has resulted in the decline of greenwood yield, largely due to inappropriate management decisions and degrading ecological health (Ong, 1995, Gong and Ong, 1995).

Hamdan et al.'s (2013) local assessment of the carbon stock indicated that the mangrove forest reserve had a loss of carbon stock of approximately 3.2 mil tCO_2e over a period of 20 years. Fig. 2 provides an example of an ideal scenario of a biomass gain and loss in a hectare of production mangrove forest as against the actual situation observed at the MMFR. In the actual situation at the MMFR, there is a fluctuation of greenwood yield or biomass accumulation due to continuous timber extraction activities. The fluctuation can be attributed to the impact of anthropogenic activities such as deep flooding, impaired regrowth, excessive thinning or delay in harvesting (Aziz et al., 2015). Recent findings on the decline of the overall carbon stock of the MMFR over time support this observation (Hamdan et al., 2013, Hamdan et al., 2014).

There have also been signs of waning in the population of Milky Stork and other migratory birds (Verheugt, 1987, Li et al., 2006, Ismail and Rahman, 2012, Rahman et al., 2013, Khaleghizadeh et al., 2014). The blood cockle industry, which is an important aquaculture activity for the community at the mangrove forest reserve, have seen a sharp

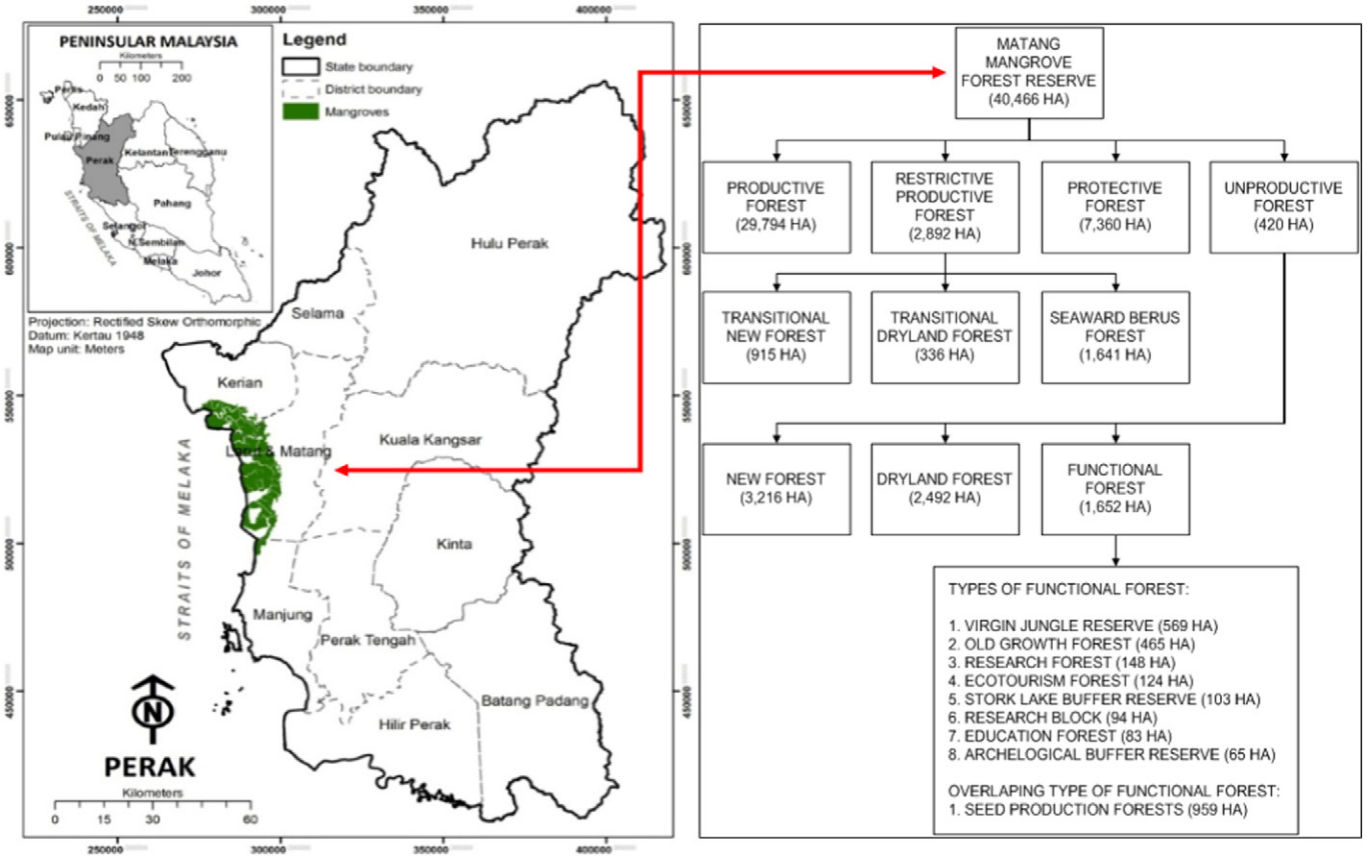

Fig. 1. The location of Matang Mangrove Forest Reserve (right) and the breakdown of the management defined forest classes (left).